

# ATLAS Program at BNL

## Detector, Performance and Physics

DOE Site Visit  
Breakout Session Discussions  
Sept 9, 2009

# Outline

- Presentation by Marc-Andre Pleier
  - *Charting New Physics Phenomena at ATLAS using Top Quarks*
  - One of our physics analysis aspirations.
- Discussions on current activities
  - Current scope, plan for future, budget impact
    - Emphasis on Core program
  - Detector M&O
  - Performance
  - Physics Analysis
  - Detector R&D for upgrade
  - (Computing/Software issues were discussed in recent briefing)

# Summary of Plan for ATLAS at BNL (Core)

- Maintain the current level of commitments to ATLAS detector M&O, software and performance
  - Crucial roles in successful ATLAS operations
- Expand Physics Analysis Efforts
  - Maximize benefits from detector and software expertise
  - Sustain our leadership roles in physics in ATLAS
  - Commitment to support US ATLAS physics analysis
    - Requires wide expertise
    - Best accomplished when we are actively doing physics
  - Transition remaining FTEs on DØ to ATLAS (2012?)
  - Additional postdocs and junior staff to carry out the planned physics analysis topics, and analysis support

# Summary of Plan for ATLAS at BNL(Core)

- Strengthen upgrade R&D program, prepare for the sLHC detector upgrade construction
  - Leading the LAr and Forward Muon upgrade, well matched to past experience
  - Established silicon strip R&D. The stave assembly production center at BNL will ensure US a leading role in ATLAS tracker upgrade
  - Current scientific staff level is insufficient for carrying out planned R&D and construction
    - Need staff scientists to take lead roles in all three areas
    - Supplemented by postdocs on detector R&D

Project	FTE
LAr	0.85
Muon	0.4
Si Tracker	1.5*
<b>Total</b>	<b>2.75</b>

Current core scientific staff on sLHC upgrade  
\*: includes new hire.



# Current and Proposed Staff Increase

## 2009-2012

Add 1 staff scientist and 1 postdoc each year  
2009 hires possible by Lissauer's on-leave,

Pleier (Assistant Physicist, Aug-09)

Gadfort (Goldhaber Fellow, Oct-09)

Increase in funding needed for later years

One postdoc position open, based on  
FY09 supplemental fund

- Split between physics analysis and detector R&D
  - Attract promising young physicists with long term career path
- Students
  - Share cost with universities
  - Cost effective in physics analysis, with close guidance by staff
  - Universities value this collaboration
  - 3 students identified already.
  - We are also working with other students without direct cost to us.

		New Hires				FY12
Staff Scientists	Current	2009	2010	2011	2012	Total
Physics Analysis	4.0	0.5			0.5	5.0
Performance	2.5					2.5
Software	2.5					2.5
Analysis Support	1.0					1.0
LAr	1.5			0.5	0.5	2.5
Muon	0.8		0.5	0.5		1.8
TC	0.2					0.2
Si R&D	1.0	0.5	0.5			2.0
<b>Total Staff:</b>	<b>13.5</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>17.5</b>
Postdocs	Current	2009	2010	2011	2012	Total
Physics Analysis	0.5	0.5	0.5	0.5	0.5	2.5
Performance	0.5					0.5
LAr	1.0	0.5		0.5		2.0
Si			0.5		0.5	1.0
<b>Total Postdocs:</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>6</b>
<b>Total Students:</b>	<b>0</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>4</b>

## BNL ATLAS Detector, Software, Performance and Physics Activities

Detector M&O	Software	LAr Calorimeter Ma,Snyder,Lanni, Majewski, Tarrade Damazio, Chen	Muon CSC Polychronakos, Assamagan,Adams Tcherniatine	Technical Coord. Polychronakos	Trigger Rajagopalan Begel, Damazio	Core Software Rajagopalan Assamagan, Ma,Snyder, Protopopescu	Dist. Comp/DM Wenaus + 10 software professionals
	Performance	e-gamma Snyder, Ma Rajagopalan	Jet/EtMiss Majewski ,Paige, Begel, Pleier	Muon Performance Adams Assamagan	$\tau$ -id Protopopescu Tarrade, Patwa		
	Early Physics	QCD dijet Begel,Majewski Paige	Z/ $\gamma$ (*)+jets Begel, Paige, Adams,Yamamoto	Inclusive $\mu$ 's Adams, Redlinger	tT di-lepton(including $\tau$ ) Mete, Searcy, Snyder,Begel, Rajagopalan,Pleier,Protopopescu Gadfort		
	Long Term Physics	Inclusive SUSY (l+Et+jets) Redlinger,Paige,Gibbard	H-> $\tau\tau$ Protopopescu, Tarrade	H->4lepton, charged Higgs Assamagan Students	new physics with tT Pleier		
	Upgrade R&D	LAr Readout Upgrade Lanni, Takai, Chen, Gadfort	Si Tracker (Strip) Lynn,Pleier	Forward Muon Polychronakos, Tcherniatine			

# FY-09 Supplemental Requests for ATLAS

- Travel for ATLAS
  - Additional Travel for preparations for LHC start-up
  - Ramp-up of R&D for ATLAS upgrade
  - \$200k requests, \$175k Received
    - Helps greatly with our increased roles in ATLAS data taking period and R&D
- Augment the ATLAS Tier-3 analysis facility at BNL
  - Computing needs for BNL's analysis activities:
    - 25X8-core CPUs, 40TB nfs disk and 100TB dCache disk
  - \$342k requested, \$100k received
    - Order of 17X8-core CPUs out, rest for disk later
    - Requires continuing yearly investment in Tier-3 for BNL physicists: ~ \$150k
- Strengthen analysis and detector R&D by two staff members and two postdocs
  - Accelerate the plan outlined in June review
  - \$320k for the remaining FY-09 requested, \$150k received.
    - One postdoc position already open. Included in the future core program.
- Equipment fund for Silicon R&D (KA15)
  - \$475k requested for wire bonder and OGP smart scope
  - Not approved.
- The support is greatly appreciated

# Budget Scenarios

- Additional staff as proposed in June Proton Research Review
  - 1 postdoc + 1 staff scientist each year (FY10-FY12)
  - Split between ATLAS Physics and Upgrade R&D
- Impact on the plan if the requested increase is reduced
  - Maintain the current level of commitments to ATLAS M&O
    - Reduction in US ATLAS Operations program already seen in FY10 budget
  - Modest expansion of the physics analysis and support
    - LHC physics is top priority.
    - Supporting USATLAS physics analysis essential for LHC physics in US
  - Maintain our leadership roles in the three areas of ATLAS upgrade R&D
    - BNL Expertise is crucial for long term LHC detector upgrade
    - Adapt the R&D plan to actual sLHC schedule
- For flat budget scenario
  - ATLAS is high priority for HEP at BNL
  - Re-direction may be necessary, subject to national priority

# ATLAS Detector M&O

- First years of operation will be challenging
- We have major responsibilities and commitments in detector operations during the data taking
  - Liquid Argon Calorimeter:
    - Front-End integration and Detector Control System
    - Develop LVPS backup options for long term reliability
    - Calibrations/Performance
  - Cathode Strip Chambers
    - Maintenance of the overall system
    - Data analysis for performance optimization
  - Trigger
    - Coordination, Calorimeter trigger, trigger performance
  - Technical coordination
    - Access & Installation, Configuration Control, coordinate US ATLAS TC effort
- Reduction in US ATLAS operations programs for detector M&O
  - Technical staff: 11 FTE in FY09 to ( expected ) 7.3 FTE in FY10
  - No increase in US ATLAS upgrade R&D
  - 1 FTE to ACF, 2.5 FTE to LArTPC ( microBooNE / LBNE )

# ATLAS Physics Analysis

- BNL has built a strong foundation for physics analysis
  - Extensive expertise in detector, software and performance
  - Lead the analysis software tool development
  - Active in physics analysis since the beginning
- Taking leadership roles: ATLAS Physics Working Group Conveners:  
K. Assamagan: Higgs (10/2008), G. Redlinger: SUSY(10/2009) , P. Steinberg(N.P.):Heavy Ion (10/2008)  
**Cultivated by many years of active roles in ATLAS physics analysis**
- Near and Long Term physics goals defined
  - Aim to staff each physics analysis with at least one leading scientist, and post-docs/ students (not all analyses are covered yet), early physics results identified.
- Benefiting US ATLAS Physics Analysis
  - Closely working with US ATLAS physicists on a few analyses
  - Analysis support for US physicists based on our own analysis expertise
  - Analysis Jamborees and LHC@BNL workshop
- **Increase in analysis effort will further expand our contributions to LHC Physics and Analysis Support**
  - **Crucial for sustaining our leadership roles**

# Core Program vs US ATLAS Operations

- Scientific Leadership from Core program, engineering and technical resources provided by the US ATLAS Operations Program
- M&O and R&D efforts are completely integrated with US ATLAS planning.
- Roles of BNL core funded personnel in US ATLAS and technical staff (FTE in FY10) working with them
  - S. Rajagopalan: Deputy Computing Manager
  - V. Polychronakos: TC and Muon (3.85 FTE)
  - F. Lanni: LAr electronics M&O and Upgrade R&D (4.6 FTE)
  - T. Wenaus: Distributed Computing ( 8.5 FTE + OSG (2 FTE) )
  - D. Lynn: Si Tracker R&D (2 FTE)
  - H. Ma + : Analysis Support Center (0.5 FTE)

## FY-09 FTEs supported by US ATLAS Operations Program on detector M&O, upgrade, software and performance at BNL

Projects	FTEs
	Operations Program
Detector M&O	11
Upgrade R&D	3
Software	8
Performance	0.5
Analysis Support	0.5
Total	23

engineers, software professionals and technicians



# ATLAS Upgrade R&D

- Upgraded LHC ( $E_{\text{cm}}=14$  TeV and  $L \sim$  a few  $1000 \text{ fb}^{-1}$ )
  - Precision measurements of new phenomena, and/or
  - Continue search for new physics at high mass scale
  - Currently no other comparable option in HEP in energy frontier
- ATLAS needs a major upgrade as luminosity increases
  - Independent of LHC phase 2 upgrade ( $L = 3 \times 10^{34}$  or  $10^{35} \text{ cm}^{-2}/\text{s}$ )
  - Challenging requirements on detector performance
  - Requires long lead detector R&D time
    - Original ATLAS detector took  $\sim 10$  years of R&D
- BNL's leadership roles in ATLAS upgrade
  - Forward muon upgrade (Phase 1 and Phase 2)
    - V. Polychronakos leads ATLAS Muon Micromegas R&D and readout electronics
  - R&D on LAr readout upgrade,  $\rightarrow$  production of new readout system
    - F. Lanni is the ATLAS LAr upgrade co-coordinator
  - R&D on Si Tracker Stave design, serial power  $\rightarrow$  Si barrel strip production center
    - D. Lynn coordinates the ATLAS Tracker Upgrade Barrel Strip Stave R&D
- Budget impact
  - Scope defined together with US ATLAS Operations program
  - Constant effort from Core and US ATLAS Operations  $\rightarrow$  longer R&D time
    - Prioritize, and focus on long lead R&D items
  - In the future we may have to drop responsibilities if funding is limited in the construction phase

Scientific staff appointments supported by the Core Research active in the detector construction, maintenance and operation or upgrade R&D

	1994-1995	2001-2003	2009	Other activities now
H. Gordon	0.5(LAr)	-	-	Project Management
D. Lissauer	1.0(LAr)	1.0 (TC)	-	NSF
H. Takai	1.0(LAr)	1.0(LAr)	0.5(LAr R&D)	Outreach
D. Rahm	1.0(LAr)	1.0(LAr)	-	Retired
I. Stumer	-	0.2(TC)	-	Retired
V. Polychronakos	1.0 (Muon)	1.0(Muon)	1.0 (Muon M&O/R&D, TC)	
R. Hackenburg	-	0.5(LAr)	-	Neutrino
V. Tcherniatine	-	1.0(Muon)	-	US ATLAS Operations
S. Rajagopalan	-	0.5(LAr)	-	Trigger
H. Ma	-	0.3(LAr)	-	Software/performance
F. Lanni	-	1.0(LAr)	0.9 (LAr M&O/R&D)	LArTPC
K. Yip	-	0.4(LAr)	-	CA-D
D. Lynn	-	-	1.0 (Si R&D)	
M-A. Pleier	-	-	0.5 (Si R&D)	Physics
Total	4.5	7.9	3.9	

Sw/Perf/Physics Effort around 2003 (Rajagopalan/Ma/Assamagan/Wenaus/Yip) 3.5 FTE

# Muon Upgrades: Future Plan

- Within the RD51 collaboration at BNL we are preparing a 2nd large area prototype, to expose on testbeam at CERN later this year.
- Readout ASICs are being developed in our Instrumentation Division. We plan to test the prototype with these devices

- **We are proposing to the ATLAS collaboration the following upgrade plan:**
- 

- **Phase-I:**
- Augment the CSC sub-system with additional MicroMegs to reinstate the original project's scope.
- **Develop Front-End ASICs to install in these new chambers.**

- **Phase-II:**
- Front-End ASIC development may become a formal responsibility for Phase-II overall Muon Upgrades (TGC/MDT chambers in the Inner and Medium Radius of the Large Wheels) if Micromegas are adopted as THE detector technology

- To support detector operations and develop R&D plans we need one additional scientific staff.
  - Currently only 0.4 FTE

# LAr Upgrades: Future Plan

- Our R&D activities will continue over the next years. On the mid and long term:
  - Coordination and mgmt of ATLAS LAr and US-ATLAS LAr
  - Readout architecture definition
  - R&D on front-end electronics
  - R&D on back-end readout
  - Performance study of an upgraded LAr detector
  - Prepare for production of both Front-End and Back-End electronics
- Additional scientific staff needed for the LAr R&D effort.
  - 1 scientist and 1 post-doc.
  - currently 0.85 FTE

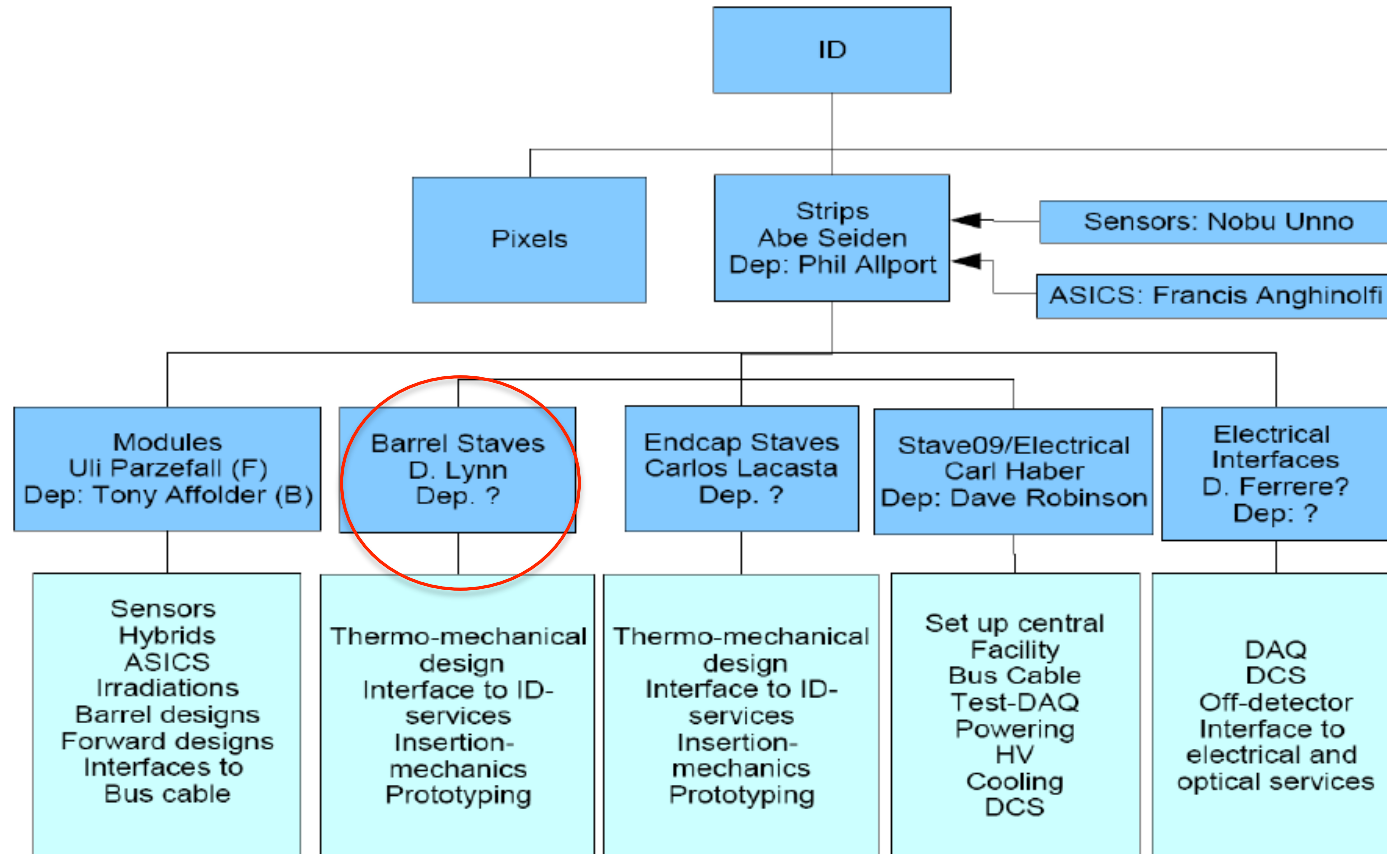
# Si Tracker Upgrades: Future Plan

- R&D plan
  1. Continue to develop the stave core design, currently is the leader of this effort
  2. Developing the techniques toward high production full stave assembly
  3. Continue our leadership role in developing the real time and slow control protection circuitry in the form of a custom ASIC
  4. Refine our early stave mount and barrel designs and make all-carbon prototypes
  5. Support DC-DC converter developments with irradiations and testing
  6. Develop module array concept that permits fast manufacturing of multiple modules
- Roles in Future Production
  - East Coast Center for final stave assembly and testing of  $\frac{1}{2}$  barrel strip staves
  - Participate with Yale in the fabrication of  $\frac{1}{2}$  the barrel stave cores
  - Provide and test the Serial Power Protection ASIC
  - Design and fabricate final carbon composite barrels
  - Be a high rate US module assembly site
- We plan an increase of 0.5 FTE scientist and 1 FTE postdoc in the next 2 year
  - Currently 1.5 FTE

# US ATLAS Plan: BNL, LBNL and SLAC for the Silicon Tracker Upgrade Construction

- Phase 1: IBL – Insertable b-layer pixels (only U.S. can do these tasks in ATLAS)
  - LBNL: Front end chips, services, stave concept for pixels
  - SLAC: 3-D detectors, power schemes, data transmission to DAQ, perhaps CO<sub>2</sub> cooling
- Phase 2: Pixels – same topics
- Phase 2: Strips – only national lab is BNL
  - BNL: ½ barrel strip stave assembly
  - Working with Yale, Stony Brook, NYU, Penn and Duke on Staves

## Proposed Organogram for ID strips in Lol/Stave09 period



19 June 2009

# Software Applications Support

Presently focused on ATLAS computing

- U.S. ATLAS Project - 7.5 FTEs

- Open Science Grid (SciDAC) – 2.5 FTEs  
(.5 'subcontracted' to UT Arlington)

Focus areas selected for US ATLAS physics analysis impact

- Distributed data management and event storage

- Production management and workflow

- Analysis systems and tools

- Software support, U.S. Librarian – complementing the Tier 1

Mature, stable and influential team

- Leadership roles in all focus areas

- ATLAS manpower ramp is complete; last hire 1.5 years ago

- Low staff turnover; no departures in 5 years

- Have shifted from development to operations as principal activity

Outlook

- 1-3 years: datataking scale-up, system refinements based on operations

- 2-5 years: development iteration

  - Scalability, manageability, tracking computing evolution

  - Many-core processing

  - Evolving distributed computing landscape (clouds, data storage)



# Software Applications Support - Principal Activities in ATLAS

## Distributed data management and event data storage

- Overall responsibility for ATLAS DDM operations
- Leading role in DDM design, implementation, management since inception

## Production management and workflow

- Principal role in developing and managing PanDA
- Distributed production and analysis system for ATLAS (& OSG)
- We also developed the production task definition system that 'feeds' PanDA
- Our systems account for the complete ATLAS production workflow

## Analysis systems and tools

'pathena' provides easy access to distributed analysis via PanDA

Now expanding from US-centric to ATLAS-wide (popular)

ATLAS has chosen PanDA as the primary tool for distributed analysis

High level expertise in ROOT, PROOF, POOL applied to analysis tools

## Software support

U.S. ATLAS Software Librarian – software installations, support

Responsible for ATLAS-wide nightly build and test systems

Software validation – focus on muon system reconstruction validation

